AOIT Computer Networking

Lesson 7

Network Standards and Protocols

Student Resources

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Student Resource 7.1

Reading: Network Protocols and Standards

Directions: In order for computers to communicate with each other across networks, they need to use common protocols and comply with standards that regulate how they communicate. There are thousands of standards, and new standards are developed every time a new technology comes out, to ensure that devices developed by different manufacturers are compatible. This reading gives you important information about the organizations that set standards for network communication, as well as the protocols and standards used by computers to communicate with each other across a network.

As you read, take notes in the table in Student Resource 7.3, answering each of the questions for each organization, standard, or protocol.

Standards Organizations

One big issue for the manufacturers who create network products, and the customers who buy them, is the question of interoperability. Will a network card from one manufacturer be able to communicate with a card from another manufacturer? Will one type of cable transport signals across all types of networks? Will networks function across products from an assortment of different manufacturers? Each manufacturer clearly needs to ensure that it uses technology that is compatible with other manufacturers’ technologies. Manufacturers do this by complying with open standards. An open standard means that the standard is not a secret that belongs to a certain company or manufacturer; it belongs to a standards organization. In these organizations, different large companies and different countries work together to establish standards that will work for everyone, often voting to determine which technology will be the “standard” technology. These are very important organizations, as they shape the way technology evolves. Generally, these are nonprofit organizations that specifically take a neutral stance regarding technologies and work for the betterment of the industry as a whole. They coordinate the creation and publication of standards documents. Part of the job of professionals who work in the field of networks is to study standards and ensure that their products comply with every detail of the standards. It is a very important marketing point to be able to say that your network device is compatible, or interoperable.

Here are some of the standards organizations that you are likely to encounter when reading about networking:

**International Organization for Standardization (ISO)** is the biggest standards organization in the world. It is a federation of standards organizations from dozens of nations. In the networking world, ISO is best known for its OSI reference model, which you will be studying in this lesson.

**American National Standards Institute (ANSI)** is the main organization responsible for coordinating and publishing computer and information technology standards in the United States. ANSI serves as the United States’ representative to ISO.

**Institute of Electrical and Electronics Engineers (IEEE)** is a well-known international professional organization for those in the electrical or electronics fields, including computers and networking. IEEE’s most important standard for the networking industry is the IEEE 802 project, which encompasses many popular networking technologies including Ethernet. You will be reading more about IEEE 802 in this reading.

**Electronic Industries Alliance (EIA)** is an international industry association that is best known for publishing electrical wiring and transmission standards. The **Telecommunications Industry Association (TIA)** is the communications sector of the EIA and is responsible for developing communications standards. Since communications, wiring, and transmission are all related, and since the TIA and EIA organizations are also related, standards produced by the EIA or TIA are often labeled with the combined acronyms “EIA/TIA” or “TIA/EIA.” When you created your own Ethernet cable, you used the EIA/TIA 568-A and 568-B standards for the color coding of your wires.

**International Telecommunication Union—Telecommunication Standardization Sector (ITU-T)** is a large international body that develops standards for the telecommunications industry. (The standards are called *ITU-T Recommendations*.) This body has played an important role in developing industry consensus since its beginnings in 1865. ITU-T Recommendations are the standards that link senders and receivers in the exchange of voice, data, and video messages over a wide range of information and communication technologies.

Serial Line Internet Protocol (SLIP)

SLIP is a very simplistic protocol that describes how data packets are sent from a computer to the Internet over a dial-up connection, for IP networks.

SLIP adds a data frame to each side of every data packet sent across the network. The “frame” shows where the packet begins and ends. This frame is just one number that is code for “end”—it is number 192 in hexadecimal.

There are a couple of problems with having such a simple protocol. First, SLIP doesn’t provide any way of detecting if there is an error in the transmission, so it can’t make any corrections.

Additionally, SLIP doesn’t provide any kind of security. For example, it doesn’t have any methods for authentication—that is, it can’t identify the computers who send and receive the packets, to make sure they’re really the ones that are meant to access the information. Another problem is that it can’t encrypt information, or conceal it as a secret code to protect it from prying eyes.

SLIP was put into use and used widely in the 1980s, but it was never standardized because people were already working on a better protocol. Even when a formal document was drawn up to approve SLIP, it was specifically labeled as a nonstandard protocol. At the same time, engineers were hard at work developing Point-to-Point Protocol, which is now more widely used.

**Further Reading:**

The TCP/IP Guide, <http://www.tcpipguide.com/free/t_SerialLineInternetProtocolSLIP.htm>

SLIP on Wikipedia, <http://en.wikipedia.org/wiki/Serial_Line_Internet_Protocol>

Point-to-Point Protocol (PPP)

PPP has mostly replaced SLIP as the protocol for how data is packaged before being sent to the Internet. It is used over many different kinds of connections, from phone lines to serial cable to fiber-optic links.

Where SLIP is a very simple protocol, PPP is more complex. It also makes frames for the data packets, but it does much more. Additionally, it has different rules that allow the network to detect if there is an error made in the transmission. It can also compress data—that is, make it smaller so that it travels faster.

PPP provides security measures as well, by authenticating the connection (verifying the identity of each computer) and encrypting data (transforming the information sent into a secret code).

Because it does so many different things, PPP is actually a protocol composed of other protocols. Each of these protocols that are a part of PPP is a list of rules that describe one of the functions of PPP.

**Further Reading:**

The TCP/IP Guide, <http://www.tcpipguide.com/free/t_PointtoPointProtocolPPP.htm>

PPP on Wikipedia, <http://en.wikipedia.org/wiki/Point-to-Point_Protocol>

Institute of Electrical and Electronics Engineers (IEEE) 802

IEEE is the organization that decides which standards will be used in electrical engineering and computer networking. The number 802 refers to a family of standards for computer networking that includes many different standards. For example, 802.3 describes Ethernet cabling and speeds. The entire document is more than 1,500 pages long.

In particular, 802.3 describes the following Ethernet speeds we use today:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Standard** | **Date** | **Specification** | **Speed** | **Cable Type** |
| 802.3an | 2006 | 10BaseT | 10 Gbps (1,250MB/sec.) | unshielded twisted pair (UTP) |
| 802.3a | 1985 | 10Base2 | 10 Mbps (1.25MB/sec.) | thin coaxial (thinnet) |
| 802.3 | 1983 | 10Base5 | 10 Mbps (1.25MB/sec.) | thick coaxial |
| 802.3j | 1993 | 10BaseF | 10 Mbps (1.25MB/sec.) | fiber optic |

**Further Reading:**

IEEE definition on Webopedia, <http://www.webopedia.com/TERM/I/IEEE.html>

IEEE 802 on Wikipedia, <http://en.wikipedia.org/wiki/IEEE_802>

Transmission Control Protocol (TCP)

TCP is one of the most important protocols, along with Internet Protocol (IP). IP is in charge of how packets are bundled, and TCP controls how they are sent. Since TCP and IP operate very closely together, they are often written together as TCP/IP.

TCP is the protocol that actually divides the packets, numbers them in order, and sets up the connection between the two computers. Then, it sends each packet individually.

Since each packet might take a different route through the network, depending on what’s fastest, the packets might arrive out of order. The computer uses the TCP rules to check the packets, make sure they’ve all arrived, and put them back in order. If one has not arrived, the computer sends a message back to say so, and the packet is resent.

When all packets have arrived and been reordered properly, they are sent to you, the computer user.

The transport layer also allows network devices to talk to different services with the same IP address on a computer by using different ports. (Computers listen on different ports, or pathways, for information coming in or flowing out of the network.) TCP is one protocol that operates at this layer to handle port numbers (the other protocol is called User Datagram Protocol, or UDP). Here’s an example involving a web server: If you use http://servername.com, you will talk to the web server on port 80. However, if you use https://servername.com, you will communicate with the same IP address, but over port 443. The port just specifies which upper layers handle the communication with the remote device.

**Further Reading:**

The TCP/IP Guide, <http://www.tcpipguide.com/free/>

TCP on Wikipedia, <http://en.wikipedia.org/wiki/Transmission_Control_Protocol>

Hypertext Transfer Protocol (HTTP)

You are probably familiar with the letters *HTTP*, because they show up at the beginning of web addresses such as http://www.google.com. Hypertext Transfer Protocol controls how web pages, graphics, and other web data are retrieved by one computer. When you open your web browser and type in a web address, your computer uses the rules defined by HTTP to retrieve all of the files used on the website so that it can be displayed on your computer.

First, HTTP tells TCP to start a connection to the web server hosting all of the website information. The HTTP, or web, server listens for requests and sends information back to your computer after you request the web page.

The folders and files that you can access are called web resources, and they are identified using addresses called Uniform Resource Locators, or URLs, for short.

**Further Reading:**

HTTP on Wikipedia, <http://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol>

HTTP definition on Webopedia, <http://www.webopedia.com/TERM/H/HTTP.html>

Dynamic Host Configuration Protocol (DHCP)

DHCP handles the automatic assignment of IP addresses to the computers on a network. DHCP is run from a server computer, which is in control of the computers people use, called client computers. The IP addresses are used to route packets in an IP network. An IP address is not a physical address, but one that can change when a computer logs on or off the network. DHCP automatically manages a list of available addresses and tracks which addresses have been assigned to which clients. Without DHCP, an administrator would have to type in IP addresses manually for each client.

Here’s how it works: When a client computer logs on to the network, it contacts the server and requests an address. The DHCP server looks through its pool of IP addresses and finds one that’s available. Once the address is assigned, the client computer can log on to the Internet.

Addresses can be static and unchanging, or change automatically after a given period of time. When a computer signs off of a network, the address it used can be reassigned to a new computer.

**Further Reading:**

DHCP definition on Webopedia, <http://www.webopedia.com/TERM/D/DHCP.html>

DHCP on Wikipedia, <http://en.wikipedia.org/wiki/Dhcp>

Student Resource 7.2

Creative Presentation: Network Protocols

Directions: Follow the specifications below to develop a creative presentation about one of the network protocols or standards you have studied.

Content

Your presentation should accomplish the following:

* Identify whether your topic is a protocol or a standard, and why.
* Describe the main functions of the protocol or standard.
* Include information about the components, cable, or signals the protocol or standard uses.

Additionally, each team member will need to be involved in either the writing or the performance of the presentation, or both.

Creative Forms

Your presentation may take any of the following creative forms, or you might develop your own way to present the information, provided you get your teacher’s permission. The performance should be one to three minutes long.

* A skit
* A song
* A TV-style news broadcast
* A demonstration

Make sure your presentation meets or exceeds the following assessment criteria:

* The presentation correctly describes the main functions of the protocol or standard.
* The presentation correctly identifies the components, cables, or devices that use the protocol or standard.
* The presentation correctly identifies the subject as a protocol or a standard, and explains why it is one or the other.
* The presentation includes contributions from all students in the group.
* The information is presented in a creative way.

Student Resource 7.3

Note Taking: Network Protocols and Standards

Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_

Directions: Follow your teacher’s instructions to fill in the tables below.

|  |  |
| --- | --- |
| In your own words, explain the purpose of standards organizations that set standards for network communication. |  |
| Give one example of a standards organization and tell why you think this organization is important. |  |

| Protocol | Is this a standard or a protocol, and why? | What components, cable, or kinds of signals use it? | What does it do? |
| --- | --- | --- | --- |
| **SLIP** |  |  |  |
| **PPP** |  |  |  |
| **TCP** |  |  |  |
| **IEEE 802** |  |  |  |
| **HTTP** |  |  |  |
| **DHCP** |  |  |  |

Student Resource 7.4

Activity Notes: The OSI Seven-Layer Model

Directions: As you learn about the various layers of the OSI seven-layer model, take notes about what you learn in this resource.

Diagram of the OSI Seven-Layer Model

Computer 2

|  |
| --- |
| 7. Application |
| 6. Presentation |
| 5. Session |
| 4. Transport |
| 3. Network |
| 2. Data Link |
| 1. Physical |

Computer 1

|  |
| --- |
| 7. Application |
| 6. Presentation |
| 5. Session |
| 4. Transport |
| 3. Network |
| 2. Data Link |
| 1. Physical |

Upper Layers:

Applications (Software)

Lower Layers:

Data Transport



Network Data Flow

Introduction — What Is the OSI Seven-Layer Model?

**Notes:**

The Lower Layers — Data Transport

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 1**  **PHYSICAL** | What does the physical layer do? | **Locate information about your network adapter:**  Your MAC address:  Device type:  Location: |
| What protocols or devices does it use? |

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 2**  **DATA LINK** | What does the data link layer do? | **Translate your hexadecimal MAC address to binary, and then to decimal.**  Binary:  Hex:  Decimal: |
| What protocols or devices does the data link layer use? |

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 3**  **NETWORK** | What does the network layer do? | Use ipconfig to find your IP address: |
| What protocols or devices does it use? |

The Upper Layers — Application and Software Support

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 4**  **TRANSPORT** | What does the transport layer do? | Use netstat –n  List all foreign IP addresses you’re connected to: |
| What protocols or devices does the transport layer use? |

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 5**  **SESSION** | What does the session layer do? | What programs on the computer initiate a session as they connect? |
| What protocols or devices does it use? |

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 6**  **PRESEN- TATION** | What does the presentation layer do? | What are some websites that use encryption to secure data? Look for the *https* in the URL. |
| What protocols or devices does the presentation layer use? |

|  |  |
| --- | --- |
| Layer Notes | System Profile |
| **LAYER 7**  **APPLI-**  **CATION** | What does the application layer do? | Which are the most commonly used application layer programs? |
| What protocols or devices does it use? |

Additional Notes:

Student Resource 7.5

Assignment Sheet: OSI Seven-Layer Model Collage

Directions: Your teacher will assign your group one layer of the OSI seven-layer model. Follow the instructions below to create a written description and a visual collage for your layer. Be sure to review the assessment criteria before you begin work.

Written Description

First, you will need to describe in writing what your layer does with the network information or data. Be sure to answer the following questions about how your layer processes the data.

* What state is the data in when it’s received from the upper or lower layer?
* What does the layer do with the information? (What does it add to, change about, or remove from the data?)
* What protocols or devices does the layer deal with, and what do they each do?
* What does the information look like when it’s sent to the next level, whether going up or down?

You can develop the most comprehensive answers by pooling your notes with your classmates’ and writing down as much information as you have collectively, as a group, gathered. You can do this by discussing each question together, or by assigning one team member to each question. Everyone in your group needs to participate in the process.

Visual Collage

The second step to explaining your layer is to understand it as a process or function, not just a set of steps. You can represent this visually by creating a collage of images that shows what the layer does.

Use images from magazines or draw your own pictures. The images can be literal or symbolic. For example, the physical layer might be represented by images of category 5 cable, routers, and hubs, to show the devices that operate on that layer. You might also use a picture of a concrete building, to show that the layer handles all of the concrete things on the network, the things that you can touch.

When you’re done, you’ll have the chance to display your work and get to see how your classmates have interpreted other layers.

Make sure your collage meets or exceeds the following assessment criteria:

* The written description accurately answers each of the questions about the steps of the assigned layer.
* The collage includes several images that accurately represent the layer’s function, steps, or devices and the protocols it uses.
* The collage includes imagery representing where the layer lies in the model in relation to the other six layers.
* Students describe how the images used on the collage represent the functions of the layer.
* The description and collage are labeled with the layer’s title, and the work is neat, with no grammatical or spelling errors.